Adaptative Image Flow in Collaborative Medical Telediagnosis Environments

Jean-Baptiste Aupet, Rami Kassab, Jean-Christophe Lapayre, Franck S. Marzani

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AUPET Jean-Baptiste*,KASSAB Rami*,LAPAYRE Jean-Christophe* and MARZANI Franck†
*LIFC Computer Science Lab. EA 4269 - UFC
16, route de Gray - 25030 Besancon Cedex - France
Email: jbaupet@lifc.univ-fcomte.fr, rami.kassab@lifc.univ-fcomte.fr, jclapayre@lifc.univ-fcomte.fr
†Laboratoire Le2i Universit de Bourgogne
B.P. 47870 21078 DIJON CEDEX - France
Email: franck.marzani@u-bourgogne.fr

***Abstract*—Telemedicine, the application of telecommunication in the medicine field, has been developed to meet major problems encountered in connecting doctors with patients and other medical staff. Having a robust and efficient telemedical system has always been a challenge. The system needs to make the members in different locations capable of sharing medical data efficiently and without errors. In this work, we present a telemedical system that overcomes these challenges. We deploy a collaborative system and adapt data to store, visualize, modify and transfer fluorescence images efficiently and robustly at the same time. We also make the system adaptive to communicate across different client platforms. We conduct experiments comparing our method with traditional collaborative system, and all results confirm our system is over others in terms of efficiency and robustness.**

***Index Terms*—daptability, Collaboration, distribution, image treatment, stitching, telemedecine, telediagnosisdaptability, Collaboration, distribution, image treatment, stitching, telemedecine, telediagnosisA**

I. INTRODUCTION

The cooperation between communication technologies and computer science in its both "hard and soft" produced a new research domain which is now called Collaborative Systems. Where we share information in a robust and secure way. In our work our system takes advantage of image processing algorithms, to have panorama imaging and share it in a collaborative system. The difficulties with processing Fluorescence images make it easier to deal with optical ones. Our system uses a sound optical acquisition system which gives us a sequence of optical and Fluorescence photos, hence the system can use the registration parameters of optical images to effect the registration of fluorescence images. Then the system shares the panoramic image in a robust and reliable collaborative system, making doctors in different geographical places of the world have a secure access to these data, where they can propose the best diagnostic.
The System also considers the multi-temporal aspect, allowing the doctor to follow the evolution of skin cancer or a cicatrix time after a time. And since most of the medical diagnoses based on visual diagnosis, image processing has a key role in this research as well.

In the first section of this paper we present the state of the art in these domains. In the following section, we define our contribution to perform collaborative image treatment and diagnosis. The last section presents the conclusion and future works.

II. STATE OF THE ART

Over the past 10 years, telemedecine and telediagnosis growth rapidly. This phenomenon is due in large part to the parallel growth in high performance networks and processors, but also due to the improvement of security in these systems. Teleworking is used in various ways such as distant learning, remote maintenance and even telemedicine.[12]

A. Medical Images

1) DICOM Standards: **Digital Imaging and Communications in Medicine (DICOM) is a standard conceived over 20 years ago for storing and transmitting medical data. This standard enables different DICOM modality such as scanners, MRI, PET, to communicate over a TCP/IP network and then exchange and store medical data into a picture archiving and communication system (PACS). The DICOM C-STORE service is used to send data to a file server (e.g. PACS). However, there is no guarantee that the data has been archived. For this reason, the Storage Commitment was introduced in addition to storage services to ensure that data received on archiving has been taken into account. It explicitly takes the responsibility of good data archiving. For example, a single workstation can implement a reception service tomography images in order to display them and then delete them after use. Another example is a scanner which produces series of medical images. Once produced, these images are sent to a server for archiving. After sending data, the scanner asks for a storage commitment. If the commitment succeeds, the scanner can delete data from its memory. Nowadays, more and more DICOM devices offer this service confirmation archiving, although this storage commitment is purely an administrative problem. Indeed, anyone can log in (username and password) on a storage device and delete some medical data.**

For image acquisition the DICOM standard will help to store and archive data. Then these images ware stored, they will accessible for everyone who has permission to watch and use them.

2) Sound Optic acquisition system: **In order to have an accurate photo of the same area of cicatrix in Fluorescence and optic (on figure 1), there is a system that uses a sound camera and an optical camera on the same axe, that gives us the same optical and Fluorescence image, hence we can use the registration parameters of optical image to register the sound image."registration parameters: parameters we use to achieve to the whole panoramic image like rotation corner, intersection area, etc...".**

This system was a little bit difficult to be initialized and used, that is exactly why we use another system that will give

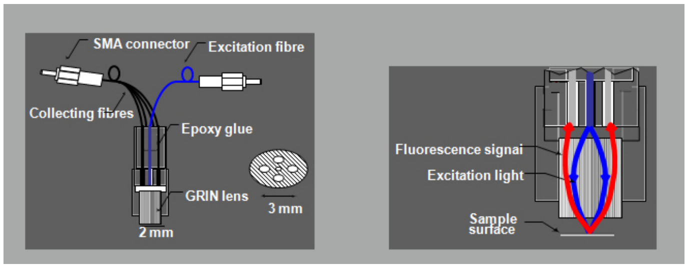

Fig. 1. previous Sound Optic acquisition system

the same results, our acquisition system is explained in the contribution section.

3) Image Registration: **Image registration is the process of overlaying two or more images of the same scene taken at different times, from different viewpoints, and/or by different sensors. It geometrically aligns two images-the reference and sensed images(Image registration methods: [8]).**
Image registration techniques varies according to the manner of the image acquisition: Different viewpoints (multi-view analysis) : 3D representation of the scanned scene.
Different times (multi-temporal analysis). Images of the same scene are acquired at different times, The aim is to find and evaluate changes in the scene which appeared between the consecutive image acquisitions.
Ex: Medical imaging-monitoring of the healing therapy, monitoring of the tumor evolution. Different sensors (multimodal analysis): Images of the same scene are acquired by different sensors[13][14].

4) Panoramic Image Stitching: **Panoramic image stitching has several researches and commercial applications. But the first steps in this domain didn't consider the approach of automatically stitching, so that they needed human input or restrictions on the image sequence in order to establish matching images. In 2007 David low proposed a solution depending on his Algorithm SIFT [7] giving invariant feature based approach to fully automatic panoramic image stitching [3]. His method is insensitive to the ordering, orientation, scale and illumination of the input images. It is also insensitive to noise images that are not part of a panorama, and can recognize multiple panoramas in an unordered image dataset.There were other researches about automatic panorama by detecting finding key points[14] and automatically matching them[10][4]**

There were many other algorithms that work on matching features, we mention in addition to SIFT, moments, winner takes all, and HFVD Harris Feature Vector Descriptor [11] which we will be used in our research.

B. Collaborative Environments for Telemedecine

A collaborative workspace or shared workspace is an inter-connected environment in which all the participants in dispersed locations can access and interact with each other just as inside a single entity.
The environment may be supported by electronic communications and groupware which enable participants to overcome space and time differentials. These are typically enabled by a shared mental model, common information, and a shared understanding by all of the participants regardless of physical location.
In order to become more innovative and competitive, companies choose software for new forms of collaboration. Instant messaging allows a direct communication and collaboration in real time. It integrates with applications and existing business processes and allows collaboration seen in the context of the task at hand. The collaborative tools used by communities to provide team members with instant access to secure content sharing, and the expertise of colleagues who may be nearby or across the globe[5]. Collaboration tools and awareness features are used to make new software more efficient than classical software in term of collaborative work level.

1) Medical Telediagnosis: **Telemedicine and e-Health are the use of electronic communication technologies as a method of delivering health care, education, and related services (medical imaging, distance teaching, patients files consultation). Dissolving barriers such as distance, time, geography, weather, and economics, applications are designed to bring services to clients rather than clients to services and improve the accessibility to the specialized health care, thanks to secured transfer of data.**
Telemedicine is generally used in a non-acute setting for patient monitoring or education and has only recently been introduced into emergency care. Telemedicine can be defined as the use of telecommunication technologies to provide medical information and services. It is the process by which electronic, visual and audio communications are used to support practitioners at remote sites with diagnosis and consultation procedures, such as remote clinical examinations and medical image transfers.
The goal of telemedicine is to allow practitioners to act as if they were at the same diagnosis table, using a varied panel of medical tools. These applications give to practitioners the possibilities to exchange their information and experiences as they were in the same room to deliberate together. CVE are environments that provide all the services to perform these applications. The rapid progress in telecommunications in recent years has allowed the practice of telemedicine to grow. Telemedicine means "*practice of medicine remotely by means of telecommunication*"

2) Adaptability: **A lot of criterion could change the system to accommodate with the users attempts, but the users wont lose their time to configure these properties of the system, especially if they want to use the system with different terminal. For example with their computer in their house or with a public access point with a PDA...[9]**
If users must change the configuration of their system each time they change of work environment, they quickly unused this system to avoid losing time at each change. Therefore the system must be adaptable, but to provide an environment that evolves with the attempts of the users, it will be adaptable and adaptive. Thats the reason why we introduce the notion of adaptive systems. The difference between adaptive and adaptable refers to the extent to which users can exert influence on the individualization process of a system. Adaptable systems are customized by the users themselves, whereas with adaptive systems this process will be made automatically [6].

A lot of criterion could change the system to accommodate with the users attempts, but the users won't lose their time to configure these criterion of the system especially if they want to use the system with different terminal. For example with their computer in their house or with a public access point with a PDA... If users must change the configuration of their system each time they change of work environment, they quickly unused this system in other environment that he has configure to avoid losing time at each change. Therefore the system must be adaptable but to provide an environment that evolves with the attempts of the users, it will be adaptable and adaptive. That's

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In CVE, several actors interact with each other in the group environment and via a multitude of media. Our basic architecture centralizes awareness in the CVE. This helps users get together being aware of one another and acting on shared data. We move towards an ”Aware Collaborative Environment” that supports multiple levels of collaboration and offers a variety of tools to develop collaborative group work. We use this awareness information to address three important notions for collaborative workspace[6].

When users have to communicate, they do not have to be impacted by the weaknesses of the others. Clients does not feel the latency of the adaptation process. But hey can not determine themselves the optimal feedback all the time. With regard to this, we propose a solution that automatically and periodically detects the changes of the environment without user’s interaction. In order to provide transparent processing, enhance the performance and facilitate the usage of the system, we propose the following architecture.

III. Contributions

A. Image Acquisition

As we mentioned before, to apply a sort of image processing as ”rotation, scaling, or panorama” over optical photos is very much easier of that on the Fluorescence ones. That is why we used the acquisition system fig:2, which makes us able to take the very same photo of the very same place on time in a white light ”normal optical photo” and the other time in Fluorescence.

The system consists of two sources of white light with a switch ”on/off”, one source of DL of 406 nm a filter of high pass with λ= 420 nm, and a CCD camera with an objective fig:2.

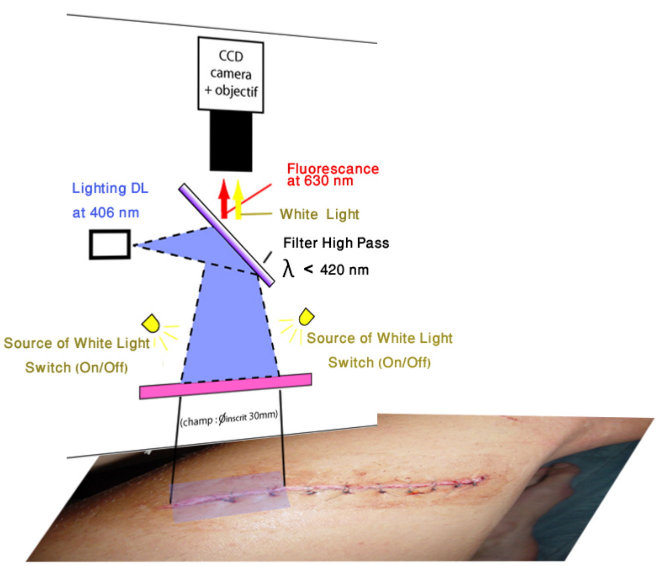

Fig. 2. Image acquisition demo -a

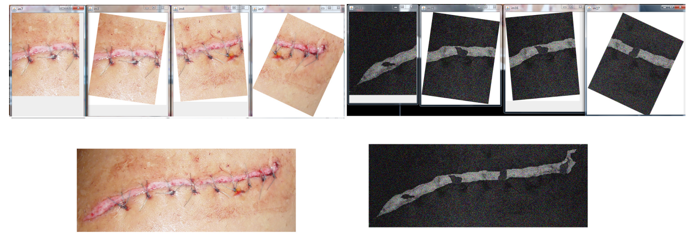

Fig. 3. Image acquisition demo -b

Each time we take a photo the white light is on we have a normal optical photo, and after a moment it is off and we have the Fluorescence one.Hence we can use the registration parameters of optical image to register the sound image.fig:3

B. Global Platform

Our local platform divided into two major parts which have been asked by the doctors:

- Multi-view
- Multi-temporal

In Multi-view tab doctor can import images (optical and sound) and ask the system to give him back the panoramic image of both optical and florescence image. In Multi-temporal tab doctor import the panoramic images of the same scar which he had over the time and the system we make the required registration of the images to make them have the very same position, to make easier to doctors to make their diagnostic.
Image stitching techniques in our work:
As we said in the state of the art image stitching process consists of several sub-processing, in our case we supposed that the variance of images is just the rotation, then we considered that the lightening effects and 3d effects are 0, in this problematic that we solved in our article it works well, but in the future if doctors said that there might be a variation of lightening or 3d, then we will develop our platform to match that.
For image stitching with a variance of rotation, first of all, we had to detect major points between images then we make the matching between them, and that made us able to precise the rotation angel between source and target image and detect the intersection area between the tow of them, then we rotate source image and we make the stitching to have a panoramic image of these two images, now we consider this image as a target one and we repeat the first step with other images until we arrive to our goal panoramic image.
We can see from the fluorescence image fig fig:3 that it’s hard to make detect any extrema, hence we can’t calculate the rotation angle, and actually that’s why we use the optical camera that takes the same photo as the fluorescence.
As well as the optical and sound images have been taken from the same axe, the rotation angel of the optical image is the same for the sound one (fig image flor and opt). Then we can finally arrive to stitch these images making the panoramic florescence image which we use to make the final image.

1) Algorithm:

We consider that this process has two main parts: detecting key points and matching each pair between two images. For detecting we have several algorithms like Harris, SIFT, Gaussian-Laplace, etc but what is important is to make the matching, the idea of matching algorithms is to find a value of the key point of the first image that will not be changed in the second, that means it will not be changed with variant modification factors ”rotation in our example”, this

value called a descriptor of the key point, in our work we had SIFT descriptor and Harris vector descriptor.
First of all, we worked with Harris corner detector algorithm, which helped us to detect successfully the interesting points or extremas, but we had to search for a feature descriptor as SIFT or moments to make us capable to find the matching between these points in each image, which will be used to calculate the rotation corner, and hence making our stitching.

We will use HFVD Harris Feature Vector Descriptor in our research. It effectively describes the image gradient distribution. By computing the mean and the standard deviation of the Harris feature vector in key point neighborhood, a novel descriptor for key points matching is constructed, which is invariant to image rigid transformation and linear intensity change. Experimental evidence suggests that the novel descriptor has a good adaptability to slight view point changing, JPEG compression as well as nonlinear change of intensity.

C. Collaborative Stitching

We suppose that the acquisition takes place in one place, and the diagnostic in another place. For example, we can have the cameras in Africa where the doctors are distributed in America, Europe, and Asia.
The Scenario will be as next:
the nurse takes the optical and fluorescence photos, and send them to our web service by any possible connection (internet, mobile, satellite, etc...), our web service will receive these images, manipulate them producing the requested panorama of both optical and fluorescence, and then distribute these two panoramas to all doctors who asked for the images Fig 4, here with the continuous orange arrow we can notice that our system sends the same panorama of the same resolution to each doctor, which can later cause a problem with the quality of the service, but that was our first step in the collaborative work without using any adaptation process, in the next paragraph we will see our solution to the quality of image problem.

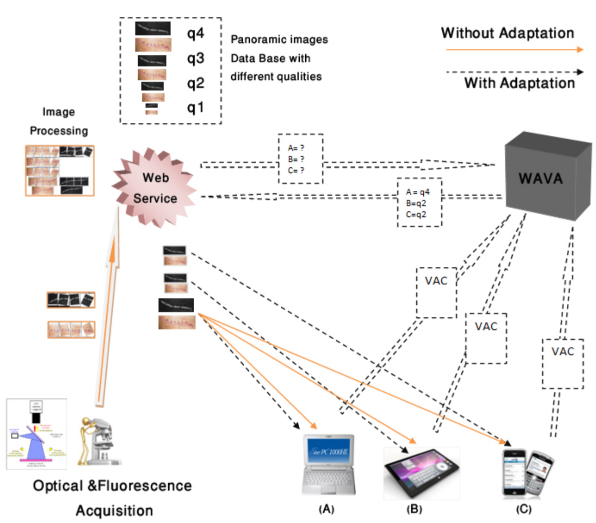

Fig. 4. Image treatment Collaborative System.

D. Adaptability Collaboration Enhancer

We suppose that every doctor could have a different type of connection to the system "Internet, Wi-Fi, 3G, etc ", and as well different devices that makes them has different capabilities, and they cannot receive the same panorama, that is why we passed to the adapted solution by adding the WAVA module, which makes the last scenario becomes like this:
First step, doctors connect to WAVA to register themselves, giving their capabilities [1], WAVA will give each of them a rank, the web service well receive the images from the acquisition party, and apply the necessary process to have the panoramic optical and Fluorescence image, making different copies with different qualities, saving them in a data base [2]. When doctors connect to web service searching panoramic images, it will send a request of quality of each of them to WAVA, which will send back the quality response, at the end the web service will send to each doctor the adapted panorama, over which he will make his diagnostic Fig 4 the dotted gray arrows.

IV. Implementation and Test

Our main goal in the implementation is to apply an efficient tests of various image processing algorithms over a library of medical images, and calculate the estimated time, in order to have a full automatic stitching of Fluorescence images, participate this panorama by a collaborative system, And then Adapt the result with each participant in our system.
For now we have two algorithms (SIFT and Harris), but our implementation is adapted to add easily other algorithms and make necessary tests. Fig:5 shows some of our results with and without adaptation, these results are taken from the previous system Fig:4, where we have three participants "doctors" (A,B,C), doctor A has a powerful device while doctor B has an IPad and doctor C has a cell phone, Fig:5 shows that without adaptation we had a huge loss of packets with B and C, which will be very much less when we apply the adaptation on our collaborative system.

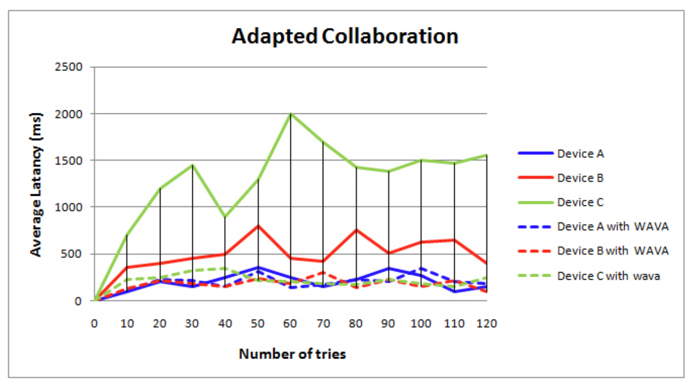

Fig. 5. Adapted Collaboration Tests

At the level of image processing our platform is designed to test the efficiency of distributing the work, for the latest algorithms in the image stitching domain, using java programming language our results show that it is faster to distribute our processing work, for example we detect the key points on several tasks.

V. Conclusion and Future Work

Thanks to merging collaboration with panoramic image processing and adaptation presented in this paper, the system assures its efficiency by giving the best results possible to have a reliable collaborative system, which is rapid enough to make the necessary image processing and sharing in an acceptable time.
This work was required by doctors and has been adapted

regarding to their needs. For the future we are working to make our system up-to-date with the latest stitching algorithms, and develop the performance of our system on two levels separately:

- collaboration, to make it more secure and robust.
- distribution, to make it more efficient.

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